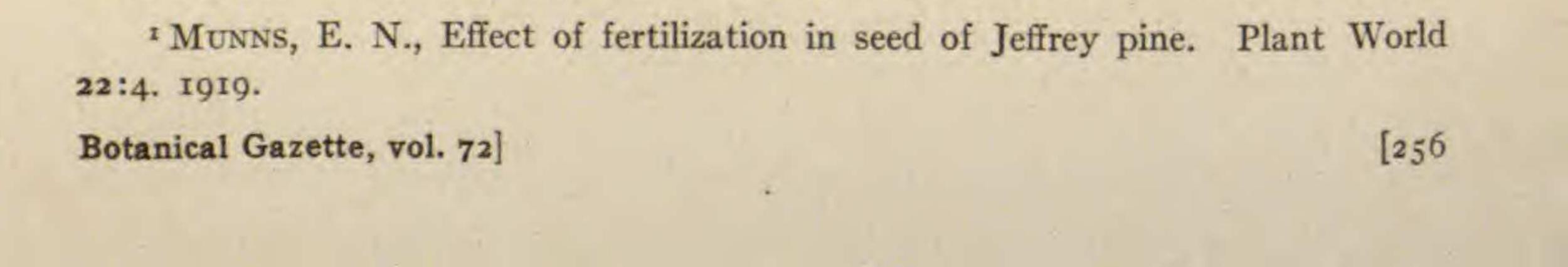
EFFECT OF LOCATION OF SEED UPON GERMINATION Edward N. Munns

The influence of parent trees upon the size and germination of Jeffrey pine seeds has been shown in a previous paper.¹ The marked results obtained from that work resulted in the present study, in which it has been sought to determine the value of seeds from different parts of the pine cone; and to decide what relation, if any, exists between the position of the seed and germination. The cones used were collected from Pinus Jeffreyi trees on the eastern slope of the Sierras in Lassen County, California, in September 1919. No attempt was made to choose the trees from which the cones were taken, except that the trees were young and growing thriftily, considering the site upon which they stood. The cones were grouped according to size in three divisions, based on the gross characteristics of length, breadth, and weight. They were dried slowly in a room at air temperature, and as they opened the seeds were extracted. The cones were divided into three sections of approximately equal size, to be known as the upper, middle, and lower portions. The seeds were carefully collected and graded into three classes, large, medium, and small, using ocular means of determining the size and comparing one seed with another. Inasmuch as a number of individuals helped to determine the size of the seed grains themselves, the individual variation from this source was very largely eliminated. The seeds were cleaned, counted, and weighed, each lot kept separately, and sufficient seeds to carry out the test taken at random from each lot. To determine the germination, a number of each lot of seeds were sown in cans containing a uniform depth of soil and covered by an approximately equal depth of sand in each case. As previous work has shown that for Jeffrey pine a soil moisture content of about 15 per cent gives the best results, frequent weighings were made to keep the moisture content of the samples a constant at this figure. The result of this study is presented in tables I-VII.



1921]

MUNNS-GERMINATION

257

It was found that there was an increase in the number of seeds with an increase in the size of the cones, medium cones having 27 per cent more seeds than the smaller ones, and the large cones

TABLE I

NUMBER AND WEIGHT OF SEED PER CONE

V Size OF CONES		NUM- BER OF	INUM-	WEIGHT OF DE-		Aver	AGE WEIG	HT PER	too seeds	5 (GM.)	
	1177	VEL-	BER OF DEVEL- OPED SEEDS PER CONE	I VEL- I	By portion of cone			By size of seed			Aver-
		PER			Upper	Middle	Lower	Large	Medi- um	Small	age for cone
Large Medium Small	228.8 189.2 145.7	69.6 58.0 37.3	62.0 51.6 38.9	5.33 4.08 2.66	8.47 7.30 6.42	8.75 8.22 7.18	8.49 7.83 7.68	10.33 9.24 7.83	8.21 7.82 6.49	6.17 5.81 6.19	8.57 7.78 7.09

TABLE II

NUMBER OF SEEDS PER CONE BY SIZE OF SEED

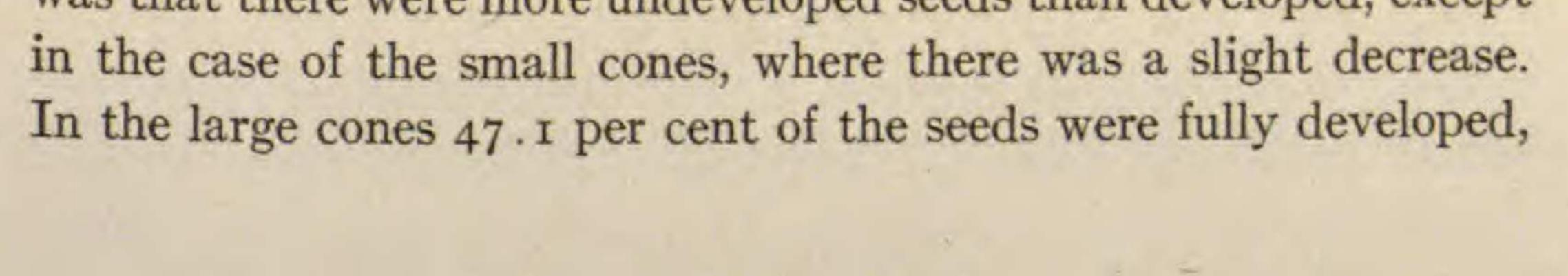
	LARGE CONES				. MEDIUM CONES				SMALL CONES			
SEEDS	Upper	Mid- dle	Lower	Total	Upper	Mid- dle	Lower	Total	Upper	Mid- dle	Lower	Total
Undeveloped Large Medium Small Total developed seeds	28.7 4.9 13.2 3.3 21.4	22.2 10.2 16.1 2.0 28.3	18.7 3.6 6.4 2.3 12.3	69.6 18.7 35.7 7.6 62.0	25.5 6.2 7.3 2.0 15.5	16.9 6.9 14.9 5.1 26.9	15.0 1.8 5.6 1.8 9.2	58.3 14.9 27.8 8.9 51.6	13.0 13.6 6.5 3.6 23.7	14.5 1.5 2.9 3.0 7.4	-19.7 2.0 4.6 1.9 8.5	47.2 17.1 14.0 8.5 39.6

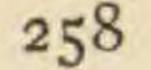
TABLE III

PERCENTAGE OF SEEDS IN CONE BY LOCATION IN CONE

	LARGE CONES				MEDIUM CONES				SMALL CONES			
SEEDS	Upper	Mid- dle	Lower	Total	Upper	Mid- dle	Lower	Total	Upper	Mid- dle	Lower	Total
Undeveloped Large Medium Small	41.2 26.2 37.0 43.4	31.9 54.5 45.1 26.3	26.9 19.3 17.9 30.3	100 100 100	43.7 41.6 26.3 22.5	29.0 46.3 53.6 57.3	27.3 12.1 20.1 20.2	100 100 100 100	27.5 79.5 46.4 42.3	30.7 8.8 20.7 35.3	41.8 11.7 32.9 22.4	100 100 100
Total developed seeds	34.5	45.6	19.9	100	30.0	52.2	17.8	100	59.8	18.7	21.5	100

51 per cent more than the small cones. Another interesting thing was that there were more undeveloped seeds than developed, except





BOTANICAL GAZETTE

[OCTOBER

in the medium cones 47.0 per cent, and in the small cones 54.2 per cent. In each cone it was found that there were twice as many large as small seeds, and more medium seeds than there were large and small seeds together, except in the small cones where there was a slight decrease.

The quantity of large seeds amounted to about 30 per cent of the total in the large and medium sized cones, and 43 per cent in the

TABLE IV

PERCENTAGE OF SEEDS IN CONE BY DEVELOPMENT AND SIZE

Seeds	LARGE CONES				MEDIUM CONES				SMALL CONES			
	Upper	Mid- dle	Lower	Aver- age	Upper	Mid- dle	Lower	Aver- age	Upper	Mid- dle	Lower	Aver- age
Developed Undeveloped		50.0 50.0	39.5 60.5	47.I 52.9	50.0 50.0	50.0	37.2 62.8	47.0	50.0 50.0	62.2 37.8	46.6	54.2 45.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
				Total				Total				Total
Large	7.9 21.3 5.3	16.5 26.0 3.2	5.8 10.3 3.7		12.0 14.1 3.9	13.4 28.9 9.9	3.5 10.8 3.5	28.9 53.8 17.3	34.4 16.4 9.1	3.8 7.3 7.6	5.0 11.6 4.8	43.2 35.3 21.5
Total	34.5	45.7	19.8	100.0	30.0	52.2	17.8	100.0	59.9	18.7	21.4	100.0

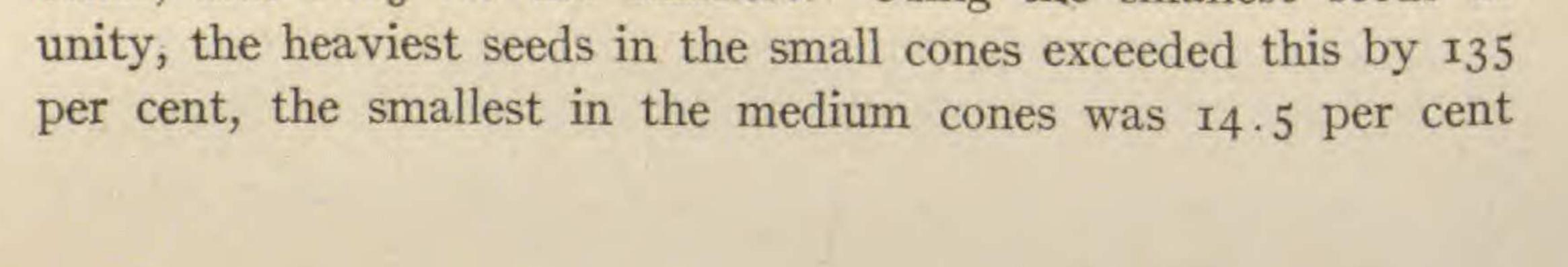
TABLE V

WEIGHT OF SEEDS IN GRAMS PER 100 SEEDS

SIZE OF SEED	L	ARGE CON	TES	MEDIUM CONES			SMALL CONES		
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Large Medium Small	10.20 8.47 5.92	10.14 8.15 6.41	11.07 7.84 6.32	8.35 7.11 4.81	9.80 8.07 6.37	10.15 8.08 5.30	7.57 5.32 4.20	8.33 7.60 6.20	9.87 7.15 5.43

small cones; medium seeds made more than 50 per cent of the total in the large and medium cones, and 35 per cent in the small cones; while the small seeds formed 12 to 17 per cent in the large and medium cones, and 21 per cent in the small cones.

The weight of seeds ranged from 4.20 to 11.07 gm. per hundred seeds, the average being 8.28 for large cones, 7.56 for medium cones, and 6.85 for the smallest. Using the smallest seeds as



MUNNS-GERMINATION

259

1921]

heavier, while the largest was 141.7 per cent. The lightest seeds in the large cones exceeded the smallest seeds by 41 per cent, and the largest seeds were 164 per cent heavier than the smallest seeds. Table VI shows that it is the size of seed rather than position in the cones which is the determining factor, there being a decided decline in the germination per cent with the size, while apparently no relation holds between position and germination. It has been shown that the weight of the seed is directly influenced by the

TABLE VI

GERMINATION PER CENT BY SIZE OF SEED AND LOCATION

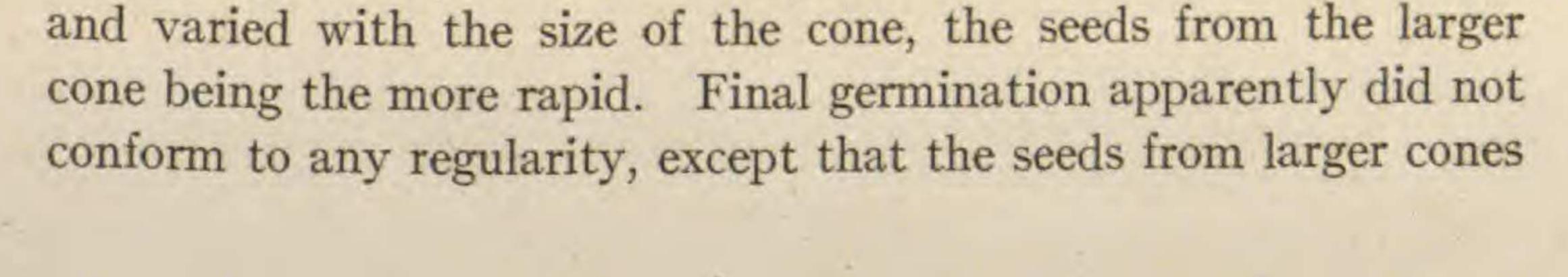
Material	Large cones	Medium cones	Small cones	Average
Large seed	66.9	58.I	55.2	60.I
Medium seed.	51.9	52.4	35.4	46.6
Small seed	35.2	25.5	23.7	28.1
Upper cones.	51.0	38.6	35.8	41.8
Middle cones	52.7	50.7	39.5	47.6
Lower cones	50.7	46.7	39.1	45.5
Average for cones	51.5	45.3	38.I	45.0

TABLE VII

GERMINATION PER CENT BY WEIGHT OF 100 SEEDS IN GRAMS

Weight per 100 seeds	Germination per cent	Weight	Germination per cent	Weight	Germination per cent
4.0		7.0	40.5	10.0	64.5
5.0		8.0	48.5	II.O	72.5
6.0	32.5	9.0	56.5	12.0	80.5

size of cone, and this is further reflected in the germination. Charting the weight and germination, it was found that a straight line relation existed, which is expressed in table VII. A curious relation was shown in the rapidity of germination. Seeds from the lower portion of the cones completed half their germination five days sooner than seeds from the middle third of the cone, which in turn were five days earlier than seeds from the upper part of the Apparently this was independent of the size of the seeds cone.



260

BOTANICAL GAZETTE

[OCTOBER

completed their germination first, followed by the medium sized cone, the small cone seeds being last, with two weeks difference between the large and small cones.

These results have an immediate application in forestation work. So far as is known, little attention is being paid to the parentage or the condition of the seed before sowing. As pointed out previously, only seeds from thrifty trees should be used, and in the present study it appears that if it is impossible to collect only the largest cones in the field, a screening process is necessary to remove the small seeds and secure only those of large size. Studies under way show a relationship between the size of seeds and the early growth and establishment of forest tree seedlings similar to that given here, and it is believed that the "dominance" classes in the forest in a measure are an index of the size of the seed from which the tree originated. To secure the best possible forest, it is believed that forest nursery practice should be confined only to the production of trees from the heaviest and therefore largest seed.

FOREST SERVICE WASHINGTON, D.C.

